The effect of synchronized group activities on pain threshold as a predictor of cooperation

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ABSTRACT

Recent research suggests that participating in vigorous synchronized physical activity may result in elevated levels of endorphins, which may in turn affect social bonding (Cohen et. al., 2009). The present research aimed to examine whether or not the change in pain tolerance would be able to predict participants' willingness to cooperate after statistically controlling for the groups' condition. Participants were asked to run on a treadmill for 30 minutes under one of two conditions (control vs. synchronized). Prior to and after the run participants underwent a pain tolerance test. Once completed, a second activity was introduced to the participants; a cooperative game. A public goods game was used to measure an individual's willingness to cooperate. The results showed the synchronized condition was able to predict that participants cooperated more during the public goods game (p = .009), however the change in pain threshold was unable to significantly predict cooperation (p = .32).

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CHAPTER ONE: LITERATURE REVIEW

Anthropologists and sociologists have studied synchronous rituals for many years, as it has been a crucial factor in human evolution (McNeill, 1995). From the development of religious groups to African warrior traditions, the emotional ties that are created by movements have a similar effect on these groups (Hannah, 1977; McNeill, 1995). Heightened emotions of well being in the individual may cause participants to feel a bond with the other group members so strong that these traditions have been passed down through the ages.

Participating in group rituals such as chanting or dancing in festivals is said to contribute to the success of small communities (McNeill, 1995). The emotions shared during the festivities have been described as euphoric (McNeill, 1995). These emotions have allowed individuals to be a part of something larger, resulting in a tightly knit community. Cohesive communities were and are still important as they enhance the group's ability to survive by improving their success during tasks such as guarding territory, securing food, and nurturing their young (McNeill, 1995). Similar to small communities, religious groups have always participated in ritualized performances of public worship. These rituals may perhaps explain the success of the Christian congregations; singing and dancing together helped in creating a cohesive church. As a result, congregations remained strong during the fourth and fifth centuries while many other religious institutions faded away (McNeill, 1995).

Synchronous group activities, and the effects that go along with them, help to promote social cohesion among any and all groups. The Dutch army, for example, in the 1590's was made up of upper and middle class citizens, along with poverty stricken peasants and urban outcasts (McNeill, 1995). The army practiced marching in step together, which seems like a terrible idea as the group would never actually perform such a task while in battle; however these drills created an emotional bond between the group members. This bond diminished the social discrimination that would have normally separated them and that discrimination became insignificant (McNeill, 1995).

Another example of participating in synchronized movements for the positive emotional outcomes is dance. In Africa, dance is traditionally used in preparation for war. Warriors take part in a warrior dance with the rest of the troops. These rituals include such activities as simultaneous stomping of feet and thunderous war cries (Hannah, 1977). Warriors have to deal with anxiety and fear leading up to battle. As these emotions build up, the traditional warrior dance helps in relieving some of the anxiety in preparation for war. The dance also helps to relieve the warriors of their anxiety by creating intense emotional reaction from participating in synchronous group activities (Hannah, 1977).

Creating relationships and bonding with others is an integral part of human nature (Miles, Nind, Henderson, & Macrae, 2010). Joint or synchronized movements may be one way of establishing these bonds. Although the terms joint action and synchronized movements seem similar, they have two different meanings.

Behavioral synchrony is described as two or more individuals who coordinate their movements in unison. The movements have been commonly described as having two key features: style and form as well as time and rhythm, meaning that any pattern of fluid movements that are performed at the same time are considered a synchronized movement (Kimura & Daibo, 2006; King & Cowlishaw, 2009; Vacharkulksemsuk & Fredrickson, 2012; Valdesolo, Ouyang & DeSteno, 2010; Wiltermuth & Heath, 2009).

An action performed for the purpose of a shared goal by at least two people is defined as a joint action (Butterfill, 2012; Valdesolo, et al. 2010; Vesper, van der Wel, Knoblich & Sebanz, 2011). Many times in order to successfully perform a joint action, such as cooperative juggling, individuals must coordinate their actions (Vesper et al., 2011). Both joint action and behavioral synchrony are related, however they are separate entities, and for the purpose of this study the focus will be on behavioral synchrony.

Humans have a natural inclination to move together in time, whether it is intentional or not (Lakens & Stel, 2011; Richardson, Marsh, Isenhower, Goodman, & Schmidt, 2007; Vacharkulksemsuk & Fredrickson, 2012). People have the ability to synchronize their movements intentionally such as a synchronized dive, or they may unintentionally fall into a synchronized movement (or rhythm), like when two people walk side by side (Lakens & Stel, 2011). A study done by Kirschner and Tomasello (2009) asked children between 2.5 and 4.5 years of age to play a drumming game with a human partner (social condition), a drumming machine (audio-visual condition) and a drum sound coming out of a speaker (acoustic condition). The results indicated that in the two nonsocial conditions, children were unable to slow down their drumming to match the beat. The children were however able to adjust their tempo when in the social condition. The children spontaneously synchronized their drumming when alongside another human (Kirschner & Tomasello, 2009). These results give light to the unique impulse humans have to share actions, emotions and experiences with other people (Tomasello, Carpenter, Call, Behne, & Moll, 2005).

The nature of social interactions is not often to synchronize our movements or even to become coordinated, however more often than not when two or more people are in motion together they tend to start coordinating their movements. Something that might be able to help explain unintentional coordination is the magnet effect. The magnet effect occurs when two or more people are performing an activity in which their movements are similar, and they each try to pull the other to their preferred sequence of movements (Schmidt & O'Brien, 1997). During a hand pendulum study, the explicit instructions under all conditions were to continue the movement at a comfortable rate independently. The researchers found that when participants were watching their partner's arm move, it was enough information to cause the magnet effect (Schmidt & O'Brien, 1997). Simply having visual information about another person's movements is enough to produce and sustain coordination.

A study done by Richardson et al. (2007) investigated how much visual information is needed for physical synchrony. Participants were randomly placed in dyad, and each dyad into visual conditions and asked to each sit in a rocking chair facing in the same direction. There were three visual conditions. In the peripheral conditions participants focused on a red 'X' on the wall in front of them. In the focal condition participants focused on an 'X' on the arm rest of the other's chair. In the no vision condition participants focused on an 'X' on the wall in the opposite direction from their partner. Participants did not become coordinated in the no visual information condition, but unintentional coordination did occur in the two conditions in which there was visual information. The focal condition had a stronger attraction than did the peripheral group, and interestingly both groups favored the phase in which participants were in complete synchrony with each other (Richardson et al., 2007).

Over the past several years there has been increasing interest in the outcomes associated with groups of people participating in synchronized activities (Valodesolo et al. 2010). There have been reports of several different effects that have occurred as a result of coordinating one's movements. McNeill (1995) stated that there are strong emotional ties that are created when groups of people move together in time. More recently there has been evidence to support the notion of synchrony having emotional outcomes. Results from a three-experiment study by Hove and Risen (2009) revealed that people experienced greater feelings of affiliation with the experimenter after synchronizing their movements. The first experiment tested the relationship between affiliation and objectively quantified synchrony. Participants tapped their right index finger on a drum pad keeping in time with a moving target on a computer screen. An experimenter sat next to the participant matching the tapping from a separate screen. Neither person could see the other screen. After the tapping task participants were asked to complete a questionnaire to determine the participant's affiliation with the experimenter. The second experiment manipulated the occurrence of synchrony, included a baseline measure of likeability and a longer tapping session to attain the skill necessary to keep in time with the target. Participants were randomly assigned to either a tapping in complete synchrony condition, a condition in which the tapping occurred opposite to the experimenter or tapping alone. Experiment three tested the interpersonal nature of the synchrony and its ability to promote affiliation. Participants tapped along with the visual and auditory target while sitting next to the experimenter who was not tapping. The results were consistent across all three experiments indicating that participants who tapped more consistently with the experimenter reported liking the experimenter more. In experiment two, the participants who tapped in complete synchrony liked the experimenter more than those who tapped at the opposite time, however they experienced no difference in the amount of enjoyment, task difficulty, mental exhaustion or perceived success with the task. The results from the third experiment interestingly reported that by just having the experimenter in the room while the participant synchronized with the target was not enough to create any feelings of liking towards the experimenter. The findings indicate that the level of interpersonal synchrony looks to be a contributing factor for likability rather than any performance of synchrony (Hove & Risen, 2009).

A common theme that arises from studies interested in the outcomes of synchronized movements is the idea that these activities foster feelings of "oneness" and a sense of bringing people together (Vacharkulksemsuk & Fredrickson, 2012). Outcomes of coordinated movements have been described as "social glue" that not only brings people together but also allows them to stay together (Valdesolo et al., 2010). The emotions people feel towards each other after performing a synchronized activity create a relationship in which complying with each other is of great importance. Building a new relationship appears to influence the behaviors of people, in that they are more willing to agree to act aggressively towards others despite what is socially acceptable (Wiltermuth, 2012). In a study done by Wiltermuth (2012), participants were asked to sit in groups of three and memorize as many words as they could from a list in three minutes. There was an incentive in the form of a chance to win 50 dollars for the people who scored in the top 25% on the memory test. Following the three-minute memorization period participants put on headphones and moved a plastic cup in time with the music. Participants were randomly assigned to one of three conditions. Before each session the participants were blindly assigned into either the persuasion condition or the non-persuasion condition. In the control group, they listened to instrumental music and simply held the cups above the table. In the synchrony condition all three participants listened to the same music and moved the cups in a specified sequence. The anti phase (complete opposite movements) synchronized group listened to the same music but with different tempos while moving the cups. After the synchronized activity the participants were informed that they could control which song the next group would listen too. The participants were given a list of songs that ranged from Lady Gaga's *Bad Romance*, Mozart's *Symphony No. 4*, to loud static noise. In the persuasion condition, a confederate would wait 3 seconds and then recited three sentences to persuade the other two to select the static noise. The non-persuasion condition had no confederate and a majority vote would decide the song. Participants who performed in the synchronous condition felt more connected with the other members of their group and were more likely to follow the request to behave aggressively towards others by choosing the static sounds for the next group (Wiltermuth, 2012). Synchrony appears to enhance the likelihood of cooperation between the members of the group.

Being able to act in synchrony with another person not only has emotional outcomes but also has a positive effect on social outcomes (Macrae, Duffy, Miles, & Lawrence, 2008; Valdesolo et al., 2010). A recent study found that acting in synchrony promoted cooperative abilities and enhanced individuals' perceptual sensitivity (Valdesolo et al., 2010). Participants were asked to take part in a 5-activity study in which perceptual sensitivity was measured using a computer screen that had a blue ball that moved from the left side of the screen to the right. During the ball's travels it passed behind a yellow rectangle. Participants were asked if the ball stayed at the same pace or hesitated when it was behind the rectangle. Participants wrote down on a sheet of paper "yes" if the ball hesitated and "no" if there was no hesitation. After they completed the task they were directed to two rocking chairs in which the participants were asked to rocked synchronously for a minute and a half. Participants then returned once more to the perceptual sensitivity task followed by the rocking chairs again. The final task was a joint task; each participant held onto one end of a large wooden labyrinth. Participants needed to work together to get the ball from one end to the other. The results revealed that the synchronous rocking increased the participant's perceptual sensitivity (able to correctly identify if there was a delay on the ball) and decreased the overall time it took dyads to complete the joint action task. The experimenters concluded that the synchronization caused feelings of rapport between the members of the dyad, which motivated them to collaborate on the joint action task (Valdesolo et al., 2010).

1.2 Phases of Synchrony

Two different phases of synchrony have been described: in-phase and anti-phase. In-phase synchrony is defined as two people who act in complete unison (Miles et al., 2010). Anti-phase occurs when two people are at opposite points of the movement, for example if two people were swinging their arms, when one person's arms are maximally forward the other person's arms would be maximally backwards (Lakens & Stel, 2011; Miles et al. 2010). Although both phases are considered stable states, in-phase is the more stable of the two, which means that when two people are together they are more likely to unintentionally and spontaneously move together in synchrony (Lakens & Stel, 2011; Miles et al. 2010; Schmidt & O'Brian, 1997).

The ability to recall information has been found to be due to the different phases of synchrony (Macrae et al., 2008; Miles et al. 2010). The degree to which the movements are synchronized has been shown to produce heightened emotions of well-being, sometimes described as euphoria (McNeill 1995; Cohen et al., 2009; Wiltermuth & Heath, 2009; Hannah, 1977). Along with several emotional outcomes that acting in synchrony has been known to promote, the ability to recall information and increase recognition has also been recently explored. Macrae et al. (2008) were interested in the extent to which participants could retain two aspects of the interaction, verbal material and the experimenter's facial appearance. All participants were randomly assigned to one of three conditions: in-phase, anti-phase, or no movement, with the experimenter as their counterpart. The experimenter sat on the other side of the table as the participants were directed to look at their face for the duration of the trial. Participants were asked to move their hand from a 90-degree position to an upright position and back upon hearing a beat from a metronome. The metronome was timed in a manner in which the participants were moving their arms in a fluid continuous movement. Participants were told to ignore the distracting words the experimenter uttered and concentrate on the movement with the metronome. The experimenter would say one word every 3 seconds, totaling 20 words throughout the trial. After the experiment was completed participants were approached by a different experimenter and asked to write down as many of the words as they could remember that the experimenter said during the session. Once they completed the list of words the participants were shown three photographs and asked to choose the one that resembled the earlier experimenter the most. Participants in the in-phase synchrony condition were able to remember more words and correctly identify the photograph more often than in the anti-phase or control conditions. There was no significant difference when simply comparing the memory results from the anti-phase and control groups (Macrae et al., 2008). It is of interest to note that although both in-phase and anti-phase are stable states of synchronization, anti-phase does not appear to be able to promote the same outcomes such as the ability to recall information.

Participating in synchronized activities has been said to promote social cohesion and allow members of a group to feel more connected to one another (Cohen et al. 2009; Miles et al. 2010; Wiltermuth & Heath, 2009). The psychological boundaries that exist between the individuals and the group may be broken down by the positive emotional ties that form when acting in synchrony (Wiltermuth & Heath, 2009). Individuals become more willing to cooperate with one another due to the outcome of the synchronized movements strengthening the social attachment between the members of the group. Although there is sufficient evidence indicating synchronized activities promote cooperation, the limitations of the relationship between synchronized activities and cooperation is still being explored. A recent study by Wiltermuth and Heath (2009) conducted a series of three experiments testing whether synchronous activities such as walking and singing can improve cooperation within groups, more specifically when such cooperation entails action that is costly to individuals. Wiltermuth and Heath (2009) predicted that synchronized activities do not need to be gross muscle movements or involve muscle bonding to promote cooperation due to the prevalence of synchronous cultural rituals that do not involve muscular bonding.

The experiments conducted by Wiltermuth and Heath (2009) asked participants to take part in a two-part study. The first part entailed either a synchronized group activity (walking or singing) or performing the task alone. After completing the initial activity, participants were then asked to take part in a fictitious second study that conducted a public goods game or weak link coordination exercise. Weak link coordination exercises and public goods games model situations in which group productivity is a function of the lowest level of input (Wiltermuth & Heath, 2009). These games measured participants' cooperation behaviours. Across all three experiments the results indicated that people acting in synchrony with others were more inclined to cooperate with others in the public goods games even in situations that required personal sacrifice (Wiltermuth & Heath, 2009). The study done by Wiltermuth and Heath (2009) demonstrated that the types of synchronized activities (i.e, walking or singing) that promote cohesion do not need to involve gross muscular movements. However there is still a gap in the literature with respect to the causal linkage between synchronized group activities and increased cooperation, or simply "why synchronized activities cause cooperation".

Recently the relationship between cooperation and synchronized movements has been under investigation, in an attempt to discover the extent of the relationship. In an attempt to find out more about the relationship a study done by

Cohen et al. (2009) looking at a college rowing crew found that endogenous opioid activation may have a social aspect to it. This study investigated the effects behavioural synchrony has on the release of endorphins. The participants took part in two sessions, one of which was performed individually and another which was performed in a group setting with five others. In each session the participants completed 45 minutes of continuous rowing on an ergometer. Power output was recorded and matched for both sessions. Pain threshold was measured and recorded before and after each session, by using a blood pressure cuff, which was placed on the participants' non-dominant arm above the elbow. The blood pressure cuff was slowly pumped up to induce ischemic pain, and participants were instructed to indicate by saying "now" at when they felt discomfort. The results of the pre and post-pain threshold tests of the individual session were compared to the results of the pre and post-test of the group session. Pain threshold was used as an indirect measure of the release of centrally released endorphins, as they are known to play a role in the pain management system. This method of measurement was chosen as an alternative to an invasive lumbar puncture needed to measure brain endorphin concentration. The results indicated that there was an increase in pain threshold following exercise in both of the conditions; however the pain threshold after the group session was significantly higher than the individual session. An increase in pain threshold may be a result of the synchronized group activity.

Past research indicates that endogenous opioids are involved in a variety of psychophysical effects including but not limited to, stress reduction, anxiolysis, mood elevation, and reduced pain perception (Boeker et al., 2008; Dishman &

O'Connor, 2009). A common phenomenon described as a state of euphoria while running, also known as a "runner's high" is caused by the release of endorphins (Boecker et al., 2008; Dishman & O'Connor, 2009; Howlette et al., 1984). Endorphins are released from the anterior pituitary when stimulated by "stress" including bouts of exercise (Boecker et al., 2008; Dishman & O'Connor, 2009; Harbach, et al., 2000; Howlett et al., 1984).

Recently there has been an increasing interest in the effects of endogenous opioids (endorphins) on social attachment and social bonding (Machin & Dunbar, 2011). For example, Machin and Dunbar (2011) stated that endorphin activity is certainly linked to social bonding in humans as well as in other species. It has been suggested that there are three possible behavioral mechanisms that are linked to the release of endorphins (Machin & Dunbar, 2011). These behavioral mechanisms are music, laughter and group-based exercise. Music in solitary experiences has been found to increase blood plasma endorphins and allow individuals to fall into euphoric states (Blood & Zatorre, 2001; Stephano, Zhu, Cadet, Salamon, & Mantione, 2004). Laughter has been argued to act as a bonding mechanism in a group context (Panksepp, 1999). Laughter has also been found to impact one’s ability to tolerate pain; when in a comedic environment individuals experienced an elevated pain threshold compared to a control condition (Dunbar et al., 2011). Kaskatis (2006) found that members of a dance class experienced an elevated pain threshold after completing the dance class compared to a less active class. The results suggest that elevated endorphins levels may only be present in higher intensity activities.

Participating in synchronized activities has a long history of rituals and traditions, of connecting the members of the group to one another. These traditions have now led to years of research to find out how important acting in synchrony is to basic human behavior. Synchronization of movements promotes feelings of affiliation and affection and builds a connection between all the members of the group (Hove & Risen, 2009; Valdesolo, Ouyang, & DeSteno, 2010). The bond that is created between all the group members inherently promotes cooperation among the members, as the emotions begin to function as a motivating factor to collaborate with one another (Valdesolo, Ouyang, & Desteno, 2010; Wiltermuth & Heath, 2009).

The emotions that arise from participating in a synchronized activity have been explained as being caused by a chemical reaction in the brain in response to physical activity. Endogenous opioids when released cause heightened emotions of well-being which may play an important role on social attachment and bonding (Cohen et al., 2009; Machin & Dunbar, 2011). The heightened endorphin release seen when a group performs an activity in synchrony may be able to explain the positive effects that are commonly seen in groups who work together.

As a result of participating in synchronized activities, an increase in endorphin levels is seen, which may increase one's willingness to cooperate in a group task. Based on the findings from previous research, which found a heightened endorphin release post synchronized group activity (Cohen et al., 2009), and that when people participated in a synchronized activity they were more inclined to cooperate afterward (Wiltermuth and Heath (2009), this leads to the intriguing the question: Does the change in pain threshold predict average cooperation after taking into account the condition the participants are in (synchronized vs. control)?

CHAPTER TWO: RATIONALE, RESEARCH QUESTIONS, & HYPOTHESES

2.1 Rationale

As discussed in the previous chapter, people who engage in synchronized group activities experience varying emotional and social benefits. Emotional benefits include feelings of well-being, pleasure, elevated moods, and a mild sense of euphoria (Cohen et al., 2009; Machin & Dunbar, 2011; Wiltermuth & Heath, 2009). Social benefits that have been reported as a result of synchronized activities are enhanced cooperation, heightened sense of social bonding and strengthened group cooperation (Cohen et al., 2009; Wiltermuth & Heath, 2009). It is well known that endorphins are released from the hypothalamus during any bout of physical activity and recent research has found that there is an even greater release of endorphins when groups of people perform a synchronized activity (Cohen et al., 2009; Machin & Dunbar, 2011). Despite the speculation and the recent interest in synchronized activities and how they contribute to group cooperation, there is little evidence of the causal link between synchronized physical activity and cooperation (Wiltermuth & Heath, 2009). It is therefore important to examine the synchrony-caused endorphin levels and the effect they have on cooperation levels. This study examined whether participants experienced heightened pain threshold in the synchronized condition and if it affected their willingness to cooperate in small groups.

2.2 Research question

The primary purpose of the investigation is to examine if the change in pain threshold would be able to predict whether or not participants would be more likely to cooperate after taking into account the conditions in which the participants were assigned. That is, does the change in pain threshold predict average cooperation after statistically controlling for the conditions the participants are in (synchronized vs. control)?

2.3 Hypothesis

The following hypothesis was put forth in response to the research question stated above:

After taking into account the conditions the participants were assigned, the change in pain threshold would successfully predict whether or not participants would cooperate more in the public goods game. Individuals who show a greater increase in pain threshold would also be the individuals who would cooperate more.

Rationale: Endorphins have been implicated to help humans bond, by strengthening the group bond (Machin & Dunbar, 2011). Participating in synchronized activities has been found to cause elevated pain thresholds, which is used as an indicator of the release of endorphins (Cohen et al., 2009). Findings from Wiltermuth and Heath (2009) showed participants cooperated more in a cooperative game, even when such cooperation entails actions that were costly to the individual, after completing a synchronous task. Individuals with higher pain threshold due to participating in a synchronous activity should then be more willing to cooperate in a cooperative task.

2.4 Limitations and Delimitations

This study aims to increase the current knowledge on the causal linkage between synchronized group activities and increased cooperation. As this linkage has not yet been explored in previous research it is important to discuss a few limitations and delimitations.

2.4.1 Limitations. The first limitation to be discussed for this study is in regards to the measurement of endorphins that were used. The first measurement for this study was to see whether the synchronized activity caused elevated endorphin levels. Due to the blood brain barrier a direct measure of endorphins would not be appropriate, as this would have required taking cerebral spinal fluid through a lumbar puncture (Cohen et al., 2009; Machin & Dunbar, 2011). Conventional practice to measure endorphin levels is by way of pain threshold, as endogenous opioids are known to play a role in the pain control system (Cohen et al., 2009; Machin & Dunbar, 2011). Pain threshold was measured by using a sphygmomanometer (blood pressure cuff). The indirect measure of endorphins was not ideal, however several previous studies including Cohen et al. (2009) and Kaskatis (2006) have used this method. The second limitation for this study was to determine the level of cooperation between the participants, as there are no standard methods for measuring cooperation, and this study used a cooperative game in which the outcomes were most beneficial when all members of the group cooperated (Andreoni, 1995; Wiltermuth & Heath, 2009).

2.4.2 Delimitations. The synchronized activity chosen for this study was a 30-minute run on a treadmill. A vigorous activity was selected, based on the results of previous studies measuring the difference in pain threshold before and after the activity (Cohen et al., 2009). Due to the nature of the running, the results of this study may only be generalizable to activities that are similar to running. The second delimitation to be discussed is the type of cooperative game chosen for this study. The cooperative game that participants played was a public goods game, which measured expectations of cooperation (Wiltermuth & Heath, 2009). The results of the game however only described the participants' actions in the game and may not be indicative in other situations outside of this study. The age of the participants is also be a delimitation as participants were recruited from undergraduate classes from Brock University in the Faculty of Applied Health Science. The ages of the majority of the participants were 18-25 years of age and the results may not transfer to other age groups.

CHAPTER THREE: METHODOLOGY

3.1 Participants

For the purpose of the present study participants were recruited from Brock University undergraduate classes from the Faculty of Applied Health Sciences. The final sample included 12 (8 male, average age of 21.25) participants in the synchronized condition and 14 (10 male, average age of 22.07) in the control condition. The synchronized condition had 11 participants who participated for the money (1 participated for course credit) with an average take away of $19.14; the control group had 9 participants who participated for the money with an average take away of $18.57.

Both men and women were eligible to participate in this study; the aim was to have equal number of male and female participants however the final sample include 8 females and 18 males. All students who were unable to perform physical activity for any health reasons were excluded from the present study (n=0). To ensure the students were able to complete the study, a Physical Activity Readiness Questionnaire (PAR-Q) questionnaire was filled out. The PAR-Q comprised of 7 yes or no questions about the individual's health. If a participant answered 'yes' to any one of the questions, he/she was excluded from taking part in the study.

3.2 Procedures

Upon receiving ethical clearance, announcements were made in undergraduate classes at Brock University to inform students of the study. Posters were also created and placed around Walker Complex in an attempt to recruit more participants for the study (See Appendix B). Participants who were interested in taking part set up a date and time to meet up with the principal investigator.

3.3 Familiarization

There was a familiarization session that took place 24-48 hours before the study. The familiarization period was used to sign all necessary forms (consent and PAR-Q) and to determine what pace would allow participants to run at approximately 70% of their maximum heart rate (See Appendices C and D). This was done ahead of time to minimize the amount of time it would have to take to determine at what pace the participants would run. Participants were asked to get on the treadmill for a couple of minutes with the heart rate monitor until the participant reached their target heart rate. Once the participant reached the target heart rate the pace was recorded and was the starting pace for the full session. This time was also used to familiarize participants with the pain tolerance test that was administered during the study.

3.4 Study

Participants were randomly assigned into groups of 3 as well, as the groups were randomly assigned into one of two conditions, synchronized or control. The synchronized group was asked to run on a treadmill for 30 minutes at anywhere from 60-79% of their maximum heart rate, and the members of that group were asked to match their footfalls to one another. All three members of this group placed their right foot down on the treadmill at the same time, alternating steps in complete synchrony. In the control condition all three members of the group started running on the treadmill at the same time and were given 2 minutes to get up to speed and ensure all the members of the group were running at different paces. In the synchronized condition the participants started on the treadmill one at a time, making sure the participants got synchronized. The researcher watched the footfalls of all 3 participants throughout the session to ensure participants remained synchronized or continued to remain unsynchronized. During the 30 minute run the researcher continuously monitored the participants to ensure they stayed as synchronized as possible. In the control condition participants were all able to run on the treadmill for 30 minutes at their own pace, independent from the other two members of the group. To ensure that the activity output was matched under both conditions, participants ran within the range of 60-79% of their maximum heart rate. A maximum heart rate of 79% was measured by calculating the participant's maximum heart rate by subtracting 220 from their age and multiplying that number by the percentage as a decimal (Plowman & Smith, 1997). A target maximal heart rate of 79% was chosen as a range from 60-79% is classified as a moderate rate of intensity for physical activity lasting anywhere from 20-60 minutes (Plowman & Smith, 1997). Following the run, participants were asked to fill out a rating of perceived exertion scale to verify all participants regardless of which condition they were in, all exerted the same amount of effort which can be seen in Appendix E (Borg, 1982).

Each participant underwent a pain tolerance test within 5 minutes before and 2 minutes after the run. In order to ensure that no more than 2 minutes passed after each participant was finished their run and when the pain tolerance test was administered the participants had a staggered finish. In the synchronized condition the start of the run was staggered, once participants ran the full 30 minutes they were asked to get off the treadmill and head to the designated area for the pain threshold test. In the control condition each participant was asked to get off the treadmill at different times, each 1 minute apart. The first participant got off the treadmill at 29 minutes, the second at 30 minutes and the third at 31 minutes. Pain threshold was measured to determine if there was a difference in tolerance pre and post exercise as well as across the conditions. After the completion of the run and the post-activity pain tolerance test, participants were introduced to a public-goods game. Participants were informed that the present study was examining the effects of exercise on decision-making.

The public-goods game was a cooperative game that was used to measure participants' cooperation (Wiltermuth & Heath, 2009). Participants received a document explaining the rules of the game and how it proceeded (See Appendix F). Each member of the group received 10 tokens for each round of the game. There were 5 rounds played totaling 50 tokens each to invest into either a public fund or a private fund. Participants were required to place all 10 of his/her tokens into at least one of the accounts each round. Each token that was placed in the private account was worth $0.30 to that person alone. For every token that was placed in the public account it earned each member of the group $0.15. For example if Player 1 placed 5 tokens in the public account and 5 tokens in the private account he/she would earn $1.50 from the private account and $0.75 from the public account, plus anything additional from the other two members of the group if he/she placed any tokens into the public account. If Player 2 placed 5 tokens into the public account and Player 3 placed 2 tokens into the public account as well, Player 1 would earn another $1.05, giving him/her a grand total of $3.30 for that round. Each participant received a piece of paper each round in which he/she filled out which account he/she would like to allocate all 10 of their tokens. The members of the groups were not permitted to talk during this game. Once the form was filled out and handed back to the researcher, the participants then received a "receipt" indicating how much money they earned in that round, as well as a running total. The receipt did not indicate which members of the group placed tokens in the public fund or how many (although they may have been able to determine it based on how many they placed into that account). The game was the most beneficial when all members of the group cooperated and contributed all of their tokens to the public account each round. The individuals who participated in the present study for the money earned during the game left the lab with the money in hand. The individuals who participated in the present study for course credit were unable to earn the money from the game and therefore did not leave the lab with any money.

3.5 Measures

3.5.1 *Intensity.* The measurement of intensity was done using three different modes of measure. Recording the pace at which the participants ran and ensuring the standard deviation is no larger than 2km/hour was the first measure. The second measure was comparing the scores from the rating of perceived exertion (RPE) to ensure that all participants were exercising at approximately the same intensity (Borg, 1982). The RPE consisted of a 15-point scale ranging from 6 (very, very light exertion) to 20 (maximum exertion) where participants circled the number that best described the amount of effort that was exerted during the 30 minute run (Borg, 1982). The third measure was heart rate as measured using a heart rate monitor and ensuring participants maintained approximately 60-79% of the maximum heart rate.

3.5.2 *Pain threshold.* The measurement of pain threshold was done using a blood pressure cuff that was placed on the participants' non-dominant arm above the elbow. The cuff was then pumped up slowly (approximately 10 mmHg per pump) until the participant felt uncomfortable. Once the participant indicated that he/she was uncomfortable by saying "now", the pressure was recorded and the pump was deflated. Pain threshold was measured before and after the participant ran for 30 minutes to find out if there was a significant difference in pain threshold after the activity as well as a difference between the two conditions. The procedure and measurement of pain threshold was a direct replication of what was done in the study by Cohen et al. (2009). Pain threshold was used as an indirect measure for endorphins, in order to find out if an increase in elevated endorphin levels had an effect on cooperation.

3.5.2 *Cooperation.* A public-goods game was used to measure the participant's expectations of the other members to cooperate (Wiltermuth & Heath, 2009). If a participant believes the other members of the group cooperated (by placing the majority or all of their tokens into the public account) then he/she will likely also place a large number of tokens into the public account. However if the participant does not believe the other members of the group cooperated (or are simply selfish) he/ she will place his/her tokens into his/her own private account. Andreoni (1995) says that under normal circumstances and conditions, participants of these games are most likely to place half of their tokens in the public account and half in the private account in the first round, and slowly start placing more tokens into the private account each round after that. Cooperation was determined by looking at the allocation of tokens; if participants placed at least half of his/her tokens into the public account in the first round and continued to place his/her tokens into the public account in the remaining rounds that was considered to be cooperative. This allowed the present study to determine if participants were more or less willing to cooperate in the game. After the cooperative game a motivation scale from 1 to 7 (1 being not motivated at all to 7 very motivated) was given to the participants to see how motivated each participant was to do well while playing the game. This was necessary as not all of the participants played the public goods game for the money, although most of them did several participated for course credit.

CHAPTER FOUR: RESULTS

4.1 Manipulation Check: Approach to data analysis

A manipulation check was conducted to ensure that the perceived intensity was matched across the synchronized and control conditions. The manipulation check was done with a *t*-test, where the dependent variable (DV) was the score given from the PRE and the independent variable (IV) was the condition in which each person participated. For this analysis a non-significant result is preferable, indicating that the scores from the RPE and average heart rate were the same across the conditions.

A manipulation check was conducted to ensure that the motivation to perform well in the cooperative game was the same for individuals who participated in the study for course credit and those who participated for the money earned during the cooperative game. This was done because several individuals participated in the present study for course credit while the majority participated for the money they earned during the cooperative game. This manipulation check was done with a *t*-test to ensure there was no difference between those who participated for the money and those who participated for course credit, where the dependent variable (DV) was the score given from the motivation scale and the independent variable (IV) was the reason for each individual who participated(for course credit or for the money). For this analysis a non-significant result is preferable, indicating that the scores from the motivation scale were the same regardless of why they were participating.

4.2 Assumptions for Manipulation Check

Prior to conducting the manipulation checks there are 3 assumptions of a *t*-test that need to be discussed and met (Field, 2009).

Normal Distribution. Average heart rate and rating of perceived exertion (RPE) were both assessed for normality by examining the mean, median, mode, standard deviation, skewness and kurtosis values.

RPE: The mean, median and mode for this scale were all similar with a mean score of 11.42 and a median and mode of 11. Standard deviation (SD) was used to determine whether or not there are outliers in the data, an outlier is any data point that is more than 3 SDs away from the mean. The RPE had a standard deviation of 1.98 which means that any data point below 5.94 or higher than 17.34 would be considered an outlier. The lowest score in the data set was 6 and the highest was 17, therefore there are no outliers. Skewness and kurtosis scores should be close to zero and in the case of PRE scores the skewness was 0.57 and kurtosis was 3.12, which simply means that there is a high concentration of data points that are the same score.

Average Heart Rate*:* The mean, median and mode for heart rate were not the same but still similar with a mean of 139.75, median of 140.13 and a mode of 134.25. Standard deviation was used to calculate whether or not there were any outliers in the data set. Average heart rate had a standard deviation of 15.17, which means that any data point below 94.19 or above 185.2 would be considered an outlier. The lowest score in the data was 101.75 and the highest was 165 and therefore there were no outliers. Skewness and kurtsis scores should be close to zero and in the case of average heart rate skewness is -0.50 and kurtosis is 0.79 and therefore has met the assumption of normal distribution.

Motivation: The mean, median and mode for motivation were not all the same but still very similar with a mean of 3.35, median of 6 and mode of 6. Standard deviation was used to calculate whether or not there were any outliers in the data set. Motivation had a standard deviation of 1.30, which means any point below 1.45 or above 9.25 would be considered an outlier. The lowest score in the data was 2 and the highest was 7 and therefore there were no outliers. Skewness and kurtosis scores should be close to zero and in the case of motivation skweness is -0.85 and kurtosis is 0.66 and therefore has met the assumption of normal distribution. There were 3 missing motivation scores; the first group that completed the study was not asked to rate his/her motivation (one individual who participated for course credit and the other two participated for the money). It was not until after the first group completed the study that the researchers realized that a motivation score would be a useful manipulation check.

Table 1

Normal Distribution of the RPE, Average Heart Rate and Motivation

Distribution		RPE_Score	Aver_HR	Motivation
	Valid	26	26	23
N	Missing	0	0	3
Mean		11.42	139.75	5.35
Median		11	140.125	6
Mode		11	134.25	6
Std. Deviation		1.98	15.17	1.30
Skewness		0.05	-0.5	-0.85
Kurtosis		3.12	0.79	0.66
Minimum		6	101.75	2
Maximum		17	165	7

Homogeneity of Variance. This assumption states that the variances should be the same throughout the data, meaning the samples comes from populations with the same variance. To determine whether the assumption of the homogeneity of variance was met a Levene's test was used. A non-significant result would indicate that the assumption was met, as the variances would be the same. The results of the Levene's test for the RPE scale showed a non-significant result indicating there were no differences in the variance across the conditions ($F(1,24)=0.49$, $p=0.491$) and therefore met the assumption (See Appendix H). The results of the Levene's test for average heat rate also showed a non-significant result indicating there was no difference in the variance across the conditions ($F_{(1,24)}= 0.14$, $p= 0.71$) and therefore met the assumption (See Appendix I). The results of the Levene's test for the motivation scale showed a non-significant result indicating there was no difference in the variance across the conditions ($F_{(1,21)}$ =0.50, p=0.49) (See Appendix J).

Independence of Scores. This assumption states that all of the scores are randomly selected and each person was only tested once. This assumption was met as each participant was only tested once.

4.3 Results : Manipulation Checks

Manipulation check of RPE. A manipulation check was conducted to ensure that the activity output was matched across both conditions. This was done with a *t*-test, where the dependent variable (DV) is the score given from the RPE and the independent variable (IV) is the condition in which each person participated. A non-significant result was found indicating that the control group's rate of perceived exertion did not differ from the synchronized group ($F_{(1,24)} = 0.71$, $t = 1.89$) (See Appendix K).

Manipulation check of Heart Rate. A second manipulation check was conducted to ensure that the activity output was matched across both conditions. This was done with a *t*-test, where the dependent variable (DV) was their average heart rate during the 30 minute run and the independent variable (IV) was the condition in which each person participated. A non-significant result was found indicating that the control group's average heart rate was not different from the synchronized group's average heart rate ($F_{(1,24)} = 0.49$, $t = 0.69$) (See Appendix L).

Manipulation check of motivation. A third manipulation check was conducted to ensure that the motivation to perform well in the cooperative game was the same for individuals who participated for course credit and those who participated for the money earned during the cooperative game (the reason for participating). This was done with a *t*-test, where the dependent variable (DV) was the score on the motivation scale and the independent variable (IV) was the reason each person participated (for course credit or for the money). A non-significant result was found indicating that the scores for individuals who participated for the money on the motivation scale did not different from the individuals who participated for course credit's motivation scores ($F_{(1, 21)} = 0.78$, $t = -0.28$)(See Appendix M).

4.4 Research Question

To address the main research question a hierarchical linear regression was conducted. To determine whether or not the change in pain threshold predicts cooperation after statistically controlling for the conditions. The DV was average cooperation score and the IVs were condition, which was entered in the first block and change in pain threshold, which was entered in the second block.

4.5 Assumptions of Hierarchical Linear Regression

Prior to conducting the analysis there are 8 assumptions of a hierarchical linear regression that need to be discussed and met (Field, 2009).

Random Sampling. This assumption states that all participants must be randomly selected and each individual cannot be used more than once. This assumption was met as each individual was only used once through the course of this study.

Univariate Normal Distribution. This assumption is met when the mean, median and mode are similar across all of the cases of a particular variable, skewness and kurtosis are close to zero, and there are no outliers more than 3 standard deviations away from the mean.

<u>Average cooperation score</u>: The mean, median and mode for average cooperation were similar with a mean of 4.84, median of 4.7 and several modes, which were 2.8 and 4.8. The mean and standard deviation of cooperation, and pre and post-pain threshold test by group can be seen in Table 2. The mean cooperation scores had a standard deviation of 2.70, which means that any data point below -3.3 or above 12.9 would be considered an outlier. The lowest score in the data was 0 and the highest was 10 and therefore there were no outliers. The skewness was 0.19 and a kurtosis was -0.45 and therefore the assumption of normal distribution was met.

Table 2

Mean and Standard Deviation of Pain Threshold and Cooperation by Conditions

	Synchrony		Control	
	Mean	Standard Deviation	Mean	Standard Deviation
Pre-Pain Threshold Test	185	94.05	193.57	76.52
Post-Pain Threshold Test	180.83	97.84	180.71	76.40
Cooperation Round 1	6.25	2.83	3.85	3.46
Cooperation Round 2	7.25	2.39	3.28	3.49
Cooperation Round 3	5.83	3.86	3.42	3.11
Cooperation Round 4	6.41	3.06	3.86	3.92
Cooperation Round 5	5.42	3.34	3.79	3.95

<u>Change in pain threshold:</u> The mean, medians are close however the mode is quite different with a mean of -8.46, a median of -10 and a mode of -30. Although the mean, median and mode are not all similar the skewness and kurtosis scores are very close to zero with the skewness of 0.17 and kurtosis of -0.71 which indicate a normal distribution. Change in pain threshold had a standard deviation of 30.94, which means that any data point below -101.28 or above 84.36 would be considered an outlier. The lowest score in the data was -70 and the highest was 50 and therefore there were no outliers and the assumption of univariate normal distribution was met (See Appendix N).

Linearity. This assumption is met when all of the independent continuous variables show a linear relationship with the dependent variable. This assumption can be met by conducting a visual inspection of a scatter plot. The linear relationship between average cooperation scores and change in pain threshold was very weak however was a linear relationship with a linearity of R^2 Linear = 0.014, therefore this assumption has been met, which can been seen in Appendix O.

Homoscedasticity. This assumption is met if equal variation in average cooperation score is seen at all levels of change in pain threshold. This assumption can be done with a visual inspection of scatter plots as well. This assumption was met as the points on the scatter plot are all of equal distance from the mean which can be seen in Appendix O.

Absence of Bivariate Outliers. This assumption states that all of the points on the scatter plot examining multiple variables should be of equal distance from the mean. This results in a shape similar to a football, with no outliers or points far away from the major grouping. This assumption can be done with a visual inspection of a scatter plot. This assumption has been met as the points on the scatter plot are all of equal distance from the mean and there are no visual outliers, which can be seen in appendix O.

Mutivariate Normal Distribution. This assumption is met when there are no outliers across all of the continuous variables. This is done by calculating a Mahalanobis' distance for each case, which is distributed as a chi square table. For this model we are looking at a critical value of $p < 0.001$ and since we have 2 continuous variables we also have 2 degree of freedom; any value above 13.81 is a multivariate outlier. The largest Mahalanobis distance in the data set is 9.21 and therefore this assumption has been met.

Multicollinearity. This assumption reviews the correlations between all of the continuous variables to check and see if any of the variables are redundant. This was done by creating a correlations table. A Pearson correlation that is above 0.8 means that the two variables are highly correlated and one of the variables should be removed from the data, as they are redundant measures (Field, 2009). This assumption was met as the correlation between mean cooperative score and change in pain threshold was below 0.8 with a score of -0.12 (See Appendix P).

Homoscedasticity of Residuals. This assumption states that all residuals are approximately equal across the predicted scores of the dependent variables. This was done by creating a scatter plot of the standardized residuals and standardized predicted value. A visual inspection was done to ensure that the data points are normally distributed and an equal distance from the line of best fit, which can be seen in appendix Q. The assumption of homoscedasticity of residuals has been met.

4.6 Results: Hierarchical Linear Regression

To determine whether or not the change in pain threshold predicts cooperation after statistically controlling for the condition, a hierarchical linear regression was conducted. The DV was cooperation and the IVs were condition (control was coded as 1, and synchrony was coded as 2), which was entered on the first block and change in pain threshold, which was entered on the second block.

Both the first block (condition) and the second block (condition and change in pain threshold) were able to significantly predict average cooperation scores (Block 1 ($F_{(1,24)}$ = 7.49, p < 0.05); Block 2 ($F_{(2,23)}$ = 4.27, p < 0.05) (See Appendix S).

In the first block condition on its own was able to account for 24% of the variation in average cooperation scores (R= 0.49, R^2= 0.24, ΔR^2=0.24, $F_{(1,24)}$=7.49, p=0.01). In the second block however, the addition of pain threshold only increased the amount of predicted variation in average cooperation scores by 3% (R= 0.52, R^2=0.27, ΔR^2=0.03). The second block was a non-significant increase in predictive abilities ($F_{(1,23)}$=1.05, p = 0.32) (See Appendix R).

The strongest and only significant predictor of average cooperation scores was condition (after the change in pain threshold was added to the model) (β = 0.51, t = 2.85, $p < .001$). Participants in the synchronized group placed 0.5 more tokens into the public account. Change in pain threshold was a non-significant predictor of average cooperation scores (β= -0.18, t=-1.02 p= 0.32). For every negative unit of change in pain threshold that is recorded, -0.1 tokens were placed into the public account (See Appendix T).

Table 3

Summary of Hierarchical Linear Regression Analysis for Variables Predicting Cooperation

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
(Constant)	1.05	1.46		0.73	1.49	
Condition	2.59	0.94	0.48	2.71	0.95	5.12
Change in pain threshold				-0.02	0.02	-0.18
R^2		0.23			0.27	
F for change in R^2		7.48			1.05	

4.7 Results: Cooperation Scores

The allocation of tokens in the public goods game was used to determine whether individuals were being cooperative. Participants were said to be cooperating if he/she placed 5 or more tokens in the first round and continued to place 4 or more tokens into the public fund in the remaining 4 rounds (Corson & Marks, 2000). In the first round the average number of tokens placed in the public account by the 12 individuals in the synchronized group was 6.25, which can be seen in Table 3. In the current study, the average number of tokens placed into the public account in any given round for the synchronized condition was above 5, indicating a moderately high amount of cooperation.

Table 4

Allocation of Average Number of Tokens Placed in Public Account Each Round

	Round 1	Round 2	Round 3	Round 4	Round 5	Mean Scores
Synchrony Group	6.25	7.25	5.83	6.41	5.42	6.23
Control Group	3.85	3.28	3.42	3.86	3.79	3.64

CHAPTER FIVE: DISCUSSION

5.1 Findings

The present study aimed to examine if change in pain threshold would be able to predict whether or not participants would be more likely to cooperate after taking into account the condition to which the participants were assigned (synchronized vs. control). Prior to any analysis, manipulation checks were conducted to ensure that the intensity were the same in both conditions. In both the control group and synchronized group the measures of workload/ intensity (RPE scale, average heart rate) were the same, meaning that any result would not have been influenced by the amount of effort that was exerted by the participants.

It was hypothesized that the change in pain threshold would be able to significantly predict individual's willingness to cooperate in the public goods game after taking into account the conditions in which the participants were placed. This hypothesis was not supported, as the condition in which the participants were placed was able to accurately predict whether or not the participants were more willing to cooperate during the public goods-game, however the change in pain threshold was unable to significantly predict additional variance in cooperation.

5.2 Synchrony and cooperation

Wiltermuth and Heath (2009) conducted a study in which participants were randomly assigned to one of four different conditions; these groups were varied in degrees of synchronization. Following the synchronized group activity, individuals participated in a cooperative game. The results of Wiltermuth and Heath's (2009) study indicated that individuals who were in the synchronized walking group were the most willing to cooperate in the game even in situations that required personal sacrifice. The synchronized walking group was the only condition in which participants engaged in physical activity. In the present study, the methods for the cooperative game were replicated and the results showed that individuals who were randomly placed into the synchronized group placed on average more tokens per round into the public account, where money would be made for all members of the group than in the control group. The results of the present study were consistent with those from the study done by Wiltermuth and Heath (2009).

Croson and Marks (2000) explained that under normal circumstances individuals place 5 tokens into the public account in the first round and then start to decrease the number to tokens placed into the public account in subsequent rounds. In the first round the average number of tokens placed in the public account by the 12 individuals in the synchronized group was 6.25, which can be seen visually in Figure 1. In the current study, the average number of tokens placed into the public account in any given round for the synchronized condition was above 5, indicating a moderately high amount of cooperation. In the present study as well as the study by Wiltermuth and Heath (2009) there was no decline in the number of tokens placed into the public account by the members of the synchronized condition. In fact the number of tokens placed into the public account by the participants in the synchronized condition from Wiltermuth and Heath's (2009) study had a very similar pattern to the results of the present study. Visually the pattern looks like the shape of an "M" where rounds 2 and 4 had the highest contributions. Rounds 1 and

5 were very similar and had the least number of tokens contributed. The biggest difference in the results was that in every round approximately 0.5-1 token more were placed into the public account in the present study. It is interesting to note that the control group in the present study on average invested more tokens into the public fund than the amount most individuals invest under normal circumstances for these types of game (Croson & Marks 2000). On average in the control condition no more than 3.79 tokens were placed in the public fund, in every round the average number of tokens placed on in the public account was 3.64.

Figure 1. *Allocation of Average Number of Tokens Placed into the Public Account*

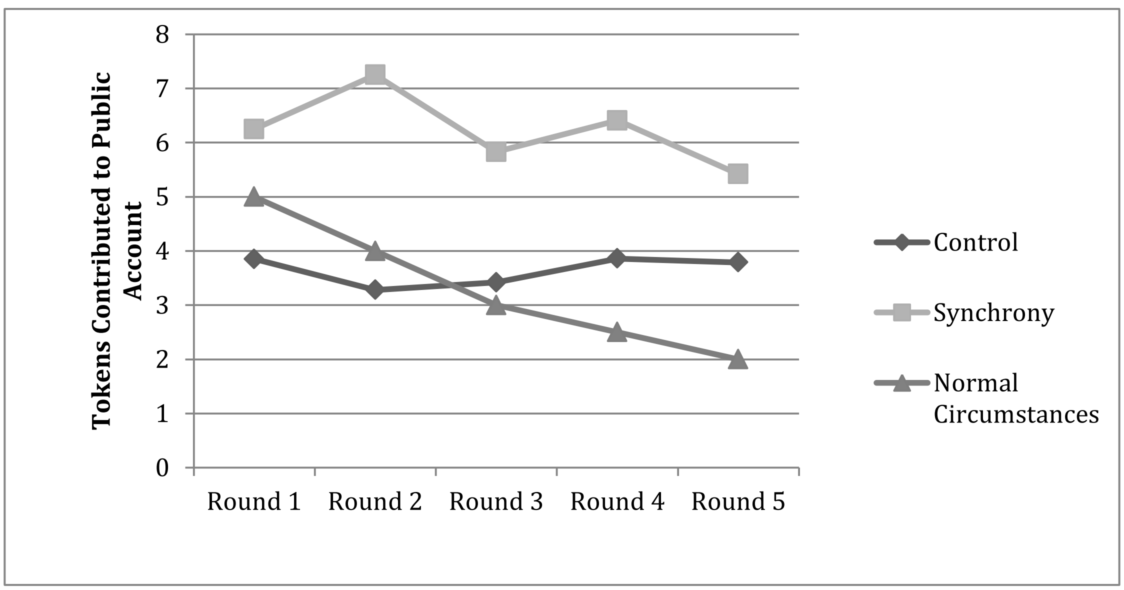

Fig. 1. Mean contributions to the public account as a function of round, plotted separately for the conditions: synchronous and control compared against number of tokens contributed under normal circumstances (Corson & Marks, 2000).

Although the results were consistent with the findings from Wiltermuth and Heath (2009), there are a few differences in the present study's methods worth mentioning. First the present study used a motivation scale (7-point Likert-type scale) after the individuals played the cooperative game because some of the individuals participated in the study for class credit and the majority participated for the money they earned during the public-goods game. This scale was used to ensure that even those who did not walk away with money still had the same motivation as those who did. The results showed there was no difference in motivation to do well in the cooperative game from the individuals who participated in the study for the money and the individuals who participated for course credit. Second, the present study only used two different conditions and in both conditions the participants ran on a treadmill for 30 minutes; even the participants who were not in the synchronized condition were still engaged in physical activity. The difference in the methods between the present study and those from Wiltermuth and Heath (2009) adds insight to the current literature on the powerful effects of synchronized movements of different intensities.

5.3 Pain threshold and cooperation

The purpose of the present study was to further the understanding of the relationship between an individual's willingness to cooperate and an increase in pain threshold. The study was unable to predict average cooperation scores using the change in pain threshold. These findings are inconsistent with previous research that has looked at the effects of synchronized physical activity on pain threshold. Cohen et al. (2009) found that after individuals participated in a synchronized group activity (45 minute row) they experienced a heightened pain threshold. Rickers (2013) replicated the methods used by Cohen et al. (2009) who also found that pain threshold increased post- in-phase synchronized rowing compared to the same individuals in the alone condition and the anti-phase synchronized condition.

The result of the present study was not able to predict average cooperation scores using the change in pain threshold. There are several differences that may explain the contradictory findings. For example, Cohen et al. (2009) used a sample of 12 varsity male athletes from Oxford University. The participants took part in two different conditions, a synchrony condition and an alone condition. The participants rowed on an ergometer for 45 minutes and the change in pain threshold from the synchronized condition was compared to the alone condition. Firstly, they only used male participants who were all varsity athletes who were all accustomed to training at a high level of intensity and on machines the athletes use frequently. Several of the participants in the current study were varsity athletes (hockey and basketball) however none of them were on the cross-country team and few of them ran on treadmills frequently. The intensity of the activity may have an impact on the results of the pain threshold test (or the release of endorphins). The studies done by Cohen et al., (2009) and Rickers (2013) have both used pain threshold as a measure for the release of endorphins as an outcome to synchronized group activities. Both studies used a 45-minute row which is the most vigorous and longest synchronized activity of any of the previous research. The inconsistent results of the present study may simply be due to the level of intensity of the activity. Another recent study done by Gagnon and Sullivan (2012) also replicated the methods of Cohen et al. (2009); the only difference was they used walking on a treadmill for 15 minutes in dyads. They compared the change in pain threshold post group synchronized to the change in pain threshold post alone condition. They did not find a significant difference between the two conditions, which may be due to the level of intensity of the synchronized activity. A higher intensity activity may be the cause of endorphin outcomes; however the members of the group are still able to reap benefits of synchronized activity at lower intensity.

Secondly, the activity that was used in the present study was running on a treadmill and even when participants were in the synchronized condition it was only their feet and arms that were matched up. Rowing is a more full body coordinated activity and when individuals synchronize their entire bodies are moving and matching, from their arms to their legs, to their head and torso. Perhaps the phenomenon of the synchrony effect is very specific to the degree of synchronization. Previous research that has looked at the degrees of synchrony have all found consistent results in that the more synchronized the group or dyad the more obvious the outcomes are. Wiltermuth and Heath (2009) used four different degrees of synchrony when looking at cooperation as the outcome. The first group was synchronous singing and moving which found the individuals in this group cooperated the most, followed closely by synchronous singing. A more recent study looking at the degree of synchrony found that there was a significant difference in pain threshold when the individuals were in complete synchrony (Rickers, 2013). The same individuals when in the anti-phase condition (at opposite points in their stroke) had a non-significant difference in pain threshold.

The results of the studies done by Wiltermuth and Heath (2009) and Rickers (2013) found that regardless of how synchronized individuals are the outcomes of synchrony, for example cooperation, are still present; the more the group is synchronized the stronger the relationship between the members becomes. Although the present study was unable to find a relationship between pain threshold and cooperation, it does still shed some light on the constructs of the synchrony effect.

5.4 Conclusion

The present study aimed to examine if the change in pain threshold would be able to predict whether or not participants would be more likely to cooperate after taking into account the conditions in which the participants were assigned. The results did not support the overall hypothesis; the study found that the change in pain threshold was not able to predict an individual's willingness to cooperate. The relationship between conditions and cooperation is consistent with previous research especially to Wiltermuth and Heath (2009). The lack of relationship between synchronized group activity and pain threshold is inconsistent with the current literature that may be due to the intensity of the activity and/or the degree of synchronization. The intensity of the activity in the present study was a moderately intense activity.

5.5 Limitations

Although the present study is the first to examine the relationship between synchronized group activities, cooperation and change in pain threshold, there are several limitations that should be acknowledged.

The first limitation is that unlike the methods of the current study, Cohen et al. (2009) and Rickers (2013) used repeated measures design, meaning the same participants were used in all of the conditions. The results that are compared across the conditions are against the same participant, whereas in the present study compared the results from different people. The present study was unable to replicate these exact methods due to the use of the cooperative game. Participants would not be able to play the cooperative game more than once without developing some sort of strategy to play which would not have been ideal. The present study therefore has some slight inconsistencies with the previous research. This difference in the design makes the present study less powerful than those using repeated measures. A repeated measures design reduces the possibility of any variation due to the individual differences to influence the results.

The second limitation of the present study is the methods by which the pain threshold test was administered. The original study done by Cohen et al. (2009) used a separate space to administer the pain tolerance tests. The space allowed the researchers to be one on one with the participant undergoing the test. The researchers were out of view of the other athletes, most likely to eliminate the possibility of the other participants to influence the results of the pain tolerance test.

However, the study done by Rickers (2013) also administered the pain tolerance test with all of the participants in the same room. The present study was unable to perform the pain tolerance test in isolation due to the lack in available lab space. The pain tolerance tests were administered away from the other participants, however all 3 participants were always in the same room. The room had 2 walls that were all mirrors, and although the pain tolerance test was administered away from the group there was nowhere that was completely private. Perhaps the inconsistent results could be partially to do with all the participants being in the same room while the pain tolerance tests were being done.

The present study added the use of a familiarization session that was conducted between 24 and 48 hours prior to the session. The familiarization session was set up to help participants to know what to expect when they came back to the study. The non-significant result with the change in pain threshold may have been affected by the familiarization session and/or by having limited space where the pain threshold test could be administered. By having participants come in early they may have been too familiar with the pain tolerance test, and were just going through the motions having done it a total of 3 times in a rather short period of time. Another possible explanation could be that although the individuals were away from the group the other members could still see the individual during the test. Having the other members present could have influenced the results of the pain threshold test, if the individuals believed he/she was being watched he/she may not have been directing all of his/her attention on the test for example.

The next limitation to discuss is the intensity of the synchronized activity. As discussed earlier that an increased pain threshold may be owing not only the synchronization but also to the vigorousness of the activity. Cohen et al. (2009) and Rickers (2013) used a 45-minute row and both studies found a significant increase in pain threshold. The present study used a 30-minute moderate run which yielded a non-significant result. The inconsistency in the results may be due to the intensity of the activity. A 30-minute run is only a moderately vigorous activity, which is not the same as a 45-minute vigorous row. Based on previous studies done by Cohen et al. (2009); Gagnon and Sullivan (2012) and Rickers (2013) it seems that the more vigorous the synchronized activity the more likely there is an increase in pain threshold.

5.6 Future Directions

Little research has examined the relationship between synchronized group activities, pain threshold and cooperation. Given the inconsistent results of increased pain threshold, more studies are needed to further our understanding of the relationship between synchronized group activities, the release of endorphins, and cooperation. Following are several recommendations that would enable future studies to build upon the current findings.

Because this study did not use a repeated measures design there are still some unanswered questions about the effects of synchronized group activities. In order to be able to determine whether or not a moderately vigorous activity causes a further increase in endorphin activity future studies should incorporate one or both of the following suggestions. Firstly, using a repeated measures design would be able to more accurately define the relationship between synchronized group activities, the release of endorphins, and cooperation. A repeated measure design allows the researcher to compare the results from one group to the same people under a different condition. For example it would be like comparing apples to apples rather than comparing apples to oranges such as the design for the present study. In order to use a repeated measures design and still be able to measure cooperation a second cooperation game would need to be used. A second game would have to be used because if you the same game was used the participants would already know how the game works and may play differently the second time. Secondly, future studies should consider removing the familiarization session. This would reduce the number of times participants completed the pain tolerance test in a short period of time and eliminate any potential problems such as simply going through the motions and/or not paying full attention during the test the second and third time doing the pain threshold test.

In addition, future research should manipulate vigorousness of the synchronized activity followed by a cooperative game. The moderate vigorous activity did not find an increase in pain threshold, however there were still prosocial benefits from the synchronized activity: cooperation. A more vigorous activity would be able to determine if the increased release of endorphins is due to a high intensity synchronized activity. A study investigating the effects of a high intensity synchronized activity on cooperation may shed some light on the outcomes associated with these type of activities, the synchronization at a high intensity could lead to an even more increase in cooperation. A less vigorous activity would still be able to help in discovering the limits of the synchrony effect. This would help to find out whether or not cooperation is still an outcome and whether the level of cooperation is the same as at the moderate or high intensity activity.

Finally, given that the level of synchronization may influence the outcomes of the activity, future studies should manipulate how synchronized the activity is. Based upon previous research the more the activity is synchronized, for example the entire body rather than just the feet and legs, the greater the outcomes. There is an increase in the release of endorphins and individuals may be more willing to cooperate. If the level of synchronization was manipulated as well as the intensity of the activity we may just be able to figure out to when the synchrony effect is seen and if it causes a further increase of positive outcomes.

5.7 Implications

Participating in physical activity, and more specifically, synchronized activities promotes prosocial behaviors (Macrea et al., 2008; Valdesolo et al., 2010; Wiltermuth & Heath, 2009). Previous research indicates that cooperation is only one of many possible outcomes of individuals participating in synchronized movements including compliance, affiliation, increased memory, and feelings of connectedness (Hove & Risen, 2009; Miles et al., 2010; Valdesolo et al., 2010; Wiltermuth 2012). All of the outcomes that have been found have real implications for any type of group looking to improve the relationship between the members.

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APPENDIX A: Ethics Clearance

Bioscience Research Ethics Board

Certificate of Ethics Clearance for Human Participant Research

DATE:	11/16/2012	
PRINCIPAL INVESTIGATOR:	SULLIVAN, Phillip – Kinesiology	
FILE:	11-062 – SULLIVAN	
TYPE:	Faculty Research	STUDENT: Morgan Gagnon SUPERVISOR: Phil Sullivan

TITLE: Synchrony effect in small groups

ETHICS CLEARANCE GRANTED

Type of Clearance: RENEWAL Expiry Date: 11/29/2013

The Brock University Bioscience Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement. Clearance granted from **11/16/2012 to 11/29/2013**.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before **11/29/2013**. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved:

Brian Roy, Chair Bioscience Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable. If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.

APPENDIX B: Recruitment Poster

WHAT: Help out a fellow Brock student by participating in ongoing research right here at Brock! Please help Morgan Gagnon (Masters candidate) and Dr. Philip Sullivan (principal investigator, psullivan@brocku.ca) with their research project: Synchrony Effect in Small Groups. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (11-062).

HOW: You are eligible to participate as long as you don't have any medical conditions that do not allow you to be physically active. The entire study shouldn't take more then an hour and a half of your time. You will be asked to **run on a treadmill** between 65-80% of your max heart rate for 30 minutes, before and after you run a pain tolerance test will be administered. After that you and the other 2 members of the group will be asked to play a decision making game where you allocate a certain number of tokens into

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APPENDIX C: Consent Form

Informed Consent for Participants

Project Title: Synchrony Effect in Small Groups

Date: December 5th, 2012

Principal Investigator:
Dr. Philip Sullivan, Associate Professor
Department of Physical Education and Kinesiology
Brock University
(905) 688-5550 Ext. 4787
phil.sullivan@brocku.ca

INVITATION
You are invited to participate in a study that involves research. The purpose of this study is to determine the difference in endorphin production in athletes during group and individual exercise.

WHAT'S INVOLVED
As a participant, you will be asked to participate in an exercise sessions and before and after each session you will be taking a pain tolerance test with a blood pressure cuff. The cuff will be placed on your non-dominate arm above the elbow. The cuff will be inflated slowly until the point in which you feel discomfort. Each exercise session will last approximately 30 minutes and after the bout of exercise you will be asked to play in a public-goods game which entails a decision making process to allocate tokens into two separate accounts. Subjects will be asked to exercise at an intensity that is no higher than their normal training exercises. It would be expected that subjects should restrain from exercising 48 hours prior to an experimental trial. The total time involved in the study (including the 30-minute sessions, pain tolerance test, and public-goods game will be approximately 1 hour).

POTENTIAL BENEFITS AND RISKS
A possible benefit of participation includes a contribution to the enhanced understanding of the role that endorphins play in exercise and group cohesion (group unity). There maybe minor risks associated with participation. Participation in exercise sessions may lead to physical fatigue. To address this risk, participants will be asked to stop exercising if they begin to experience any adverse reactions to physical exercise (e.g., dizziness, light-headedness, etc.). To compensate participants for these risks, you will receive the money earned during the public-goods game, which will range from $10.00-$22.50 in cash at the completion of your participation.

CONFIDENTIALITY
All information you provide is considered confidential; your name will not be included or, in any other way, associated with the data collected in the study. Furthermore, because our interest is in the average responses of the entire group of participants, you will not be identified individually in any way in written reports of this research. Data collected during this study will be stored in a locked office at Brock University. Data will be kept for two years after which time all documents will be shredded and data discarded. Access to this data will be restricted to Dr. Philip Sullivan.

VOLUNTARY PARTICIPATION
Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time and may do so without any penalty or loss of benefits to which you are entitled.

PUBLICATION OF RESULTS
Results of this study may be presented at conferences. Feedback about this study will be available from Dr. Philip Sullivan at phil.sullivan@brocku.ca. Feedback will be available within six months of your participation.

CONTACT INFORMATION AND ETHICS CLEARANCE
If you have any questions about this study or require further information, please contact the Principal Investigator or the Faculty Supervisor (where applicable) using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (11-062). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Thank you for your assistance in this project. Please keep a copy of this form for your records.

CONSENT FORM
I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Name: ___________________________

Signature: _______________________________ Date: ___________________________

Please use the following scale to state how motivated you were to perform well in this game.

Not motivated At all   Highly Motivated

1 2 3 4 5 6 7

APPENDIX D: Physical Activity Readiness Questionnaire

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME ____

SIGNATURE ____ DATE ____________________

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) ____ WITNESS ____________________

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

APPENDIX E: RPE Scale

rating	description
6	NO EXERTION AT ALL
7	
	EXTREMELY LIGHT
8	
9	VERY LIGHT
10	
11	LIGHT
12	
13	SOMEWHAT HARD
14	
15	HARD (HEAVY)
16	
17	VERY HARD
18	
19	EXTREMELY HARD
20	MAXIMAL EXERTION

APPENDIX F: Public goods-game instructions

Public Goods-Game Instructions Transcript

The instructions are simple, if you follow them carefully and make good investment decisions you may earn a considerable amount of money. The money you earn will be paid to you in cash, at the end of the experiment.

The Investment Opportunities

You have been placed into a group of 3 people, each of you will be given an investment account with a specific number of tokens in it. These are then invested to turn into cash. *All tokens much be invested to earn cash from them.* You will be choosing how to divide your token between two investment opportunities:

1. The Individual Account

Every token you invest in the Individual Account will earn you a return of $0.30 (30 cents).

Example: Suppose you invested 5 tokens in the Individual Account, then you would earn $1.50 (1 dollar, 50 cents).

Example: Suppose you invested 10 tokens in the Individual Account, then you would earn $ 3.00 (3 dollars).

Example: Suppose you invested 0 tokens in the Individual Account, then you would earn nothing.

2. The Group Account

The return you earn from the Group Account is a little more difficult to determine. What you earn from the Group Account will depend on the *total number of tokens* that you and the other 2 members of the group invest in the Group Account. The more the group invests in the Group Account the more *each member of the group* earns. The process is best explained by a number of examples:

Example: Suppose that you decide to invest no tokens in the Group Account, but that the 2 other members invested a total of 10 tokens. Then your earnings from the Group Account would be $1.50 (1 dollar, 50 cents). Everyone else in the group would also earn $1.50, from the Group Account.

Example: Suppose that you invested 5 tokens in the Group Account and the other 2 members invested a total of 12 tokens. This makes a total of 17 tokens. Your return from the Group Account would be $2.55 (2 dollars, 55 cents). The other members of your group would also earn $2.55 from the Group Account.

Example: Suppose that you invested 7 tokens in the Group Account, but that the other four members of the group invest nothing. Then you, and everyone else in the group would get a return from the Group Account of $1.05 (1 dollar, 5 cents).

As you can see, every token invested in the Group Account will earn $0.15 (15 cents) for every member of the group, not just the person who invested it. *It does not matter who invests in the Group Account, everyone will get a return from every token invested- whether they invest in the Group Account or not.*

The Investment Decision

Your task is to decide how many of your tokens to invest in the Individual Account and how many to invest in the Group Account. You are free to put some tokens into the Individual Account and some into the Group Account. Alternatively you can put all of them into the Group Account or all of them in the Individual Account.

Your Investment Account

The number of tokens in your Investment Account is indicated on your Investment Decision Form. You and every other member of your group will have 10 tokens in your investment account each decision round. The total number of tokens in each group in every decision round is 30.

Stages Of Investment

There will be 5 decision rounds in which you will be asked to make investment decisions. At the end of each round your payoff will be recorded by the experimenter. After the last round you will be paid the total of your payoffs from all 5 rounds. At the beginning of each round you will be given a fresh investment account. You will also be given an *Investment Decision Form*. You are to record your decision using this form. Be sure that your investment in the Individual Account plus your investment in the Group Account equals the number of tokens in your account (10 tokens). You must make your investment decisions *without* knowing what the others in your group are deciding. **Do not discuss your decision with any other participant!**

The experimenter will collect the form when you have filled it out. The experimenter will then calculate your earnings from the Individual and Group Account, and calculate your total payoff. This information will be conveyed to you on an Earnings Report.

Important Notice: The earnings report tells you the total investment in the Group Account and your personal earnings. It does not tell you the investment decisions or earnings of the other members of your group. YOUR INVESTMENT DECISIONS AND EARNINGS ARE CONFIDENTIAL.

GOOD LUCK!

APPENDIX G: Normal Distribution Table

Statistics				
		RPE_Score	aver_HR	Motivation
N	Valid	26	26	23
	Missing	0	0	3
Mean		11.42	139.7500	5.35
Median		11.00	140.1250	6.00
Mode		11	134.25	6
Std. Deviation		1.983	15.17498	1.301
Skewness		.057	-.500	-.855
Std. Error of Skewness		.456	.456	.481
Kurtosis		3.123	.797	.660
Std. Error of Kurtosis		.887	.887	.935
Minimum		6	101.75	2
Maximum		17	165.00	7

APPENDIX H: Test of Homogeneity of Variance of RPE Scores

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
RPE_Score	Based on Mean	.490	1	24	.491
	Based on Median	.891	1	24	.355
	Based on Median and with adjusted df	.891	1	23.785	.355
	Based on trimmed mean	.707	1	24	.409

APPENDIX I: Test of Homogeneity of Variances of Average Heart Rate

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
aver_HR	Based on Mean	.144	1	24	.708
	Based on Median	.091	1	24	.765
	Based on Median and with adjusted df	.091	1	23.174	.765
	Based on trimmed mean	.116	1	24	.736

APPENDIX J: Test of Homogeneity of Variances of Motivation

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Motivation	Based on Mean	.500	1	21	.487
	Based on Median	.235	1	21	.633
	Based on Median and with adjusted df	.235	1	20.427	.633
	Based on trimmed mean	.493	1	21	.491

APAPPENDIX K: T-test for RPE

Group Statistics

	Condition	N	Mean	Std. Deviation	Std. Error Mean
RPE_Score	Control	14	12.07	2.018	.539
	Synchrony	12	10.67	1.723	.497

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
RPE_ Score	Equal variances assumed	.490	.491	1.891	24	.071	1.405	.743
	Equal variances not assumed			1.915	24.00	.068	1.405	.734

APPENDIX L: T-test for Heart Rate

Group Statistics					
	Condition	N	Mean	Std. Deviation	Std. Error Mean
aver_HR	Control	14	141.6786	14.17522	3.78849
	Synchrony	12	137.5000	16.60230	4.79267

Independent Sample Test									
		Levene's Test for Equality of Variances		t-test for Eqaulity of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
aver_HR	Equal Variances Assumed	0.144	0.708	0.693	24	0.495	4.17857	6.03291
	Equal Variances Not Assumed			0.684	21.83	0.501	4.17857	6.1092

APPENDIX M: T-test for motivation on Cooperative Game

Group Statistics					
	money	N	Mean	Std. Deviation	Std. Error Mean
Motivation	Course Credit	5	5.20	1.924	.860
	Money	18	5.39	1.145	.270

Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Motivation	Equal variances assumed	1.205	.285	-.281	21	.781	-.189	
	Equal variances not assumed			-.210	4.815	.843	-.189	.902

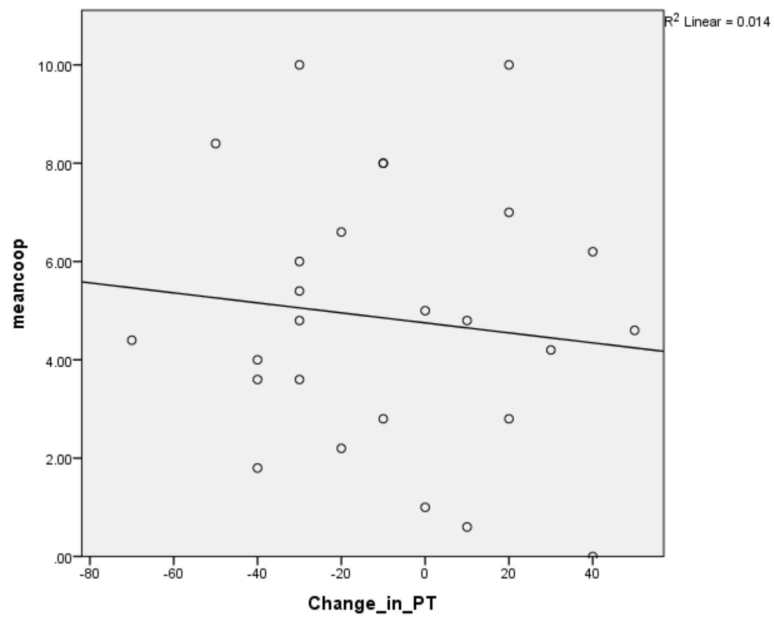
APPENDIX N: Univariate Normal Distribution

Statistics

		meancoop	Change_in_PT
N	Valid	26	26
	Missing	0	0
Mean		4.8385	-8.46
Median		4.7000	-10.00
Mode		2.80[a]	-30
Std. Deviation		2.70053	30.944
Skewness		.196	.169
Std. Error of Skewness		.456	.456
Kurtosis		-.452	-.705
Std. Error of Kurtosis		.887	.887
Minimum		.00	-70
Maximum		10.00	50

a. Multiple modes exist. The smallest value is shown

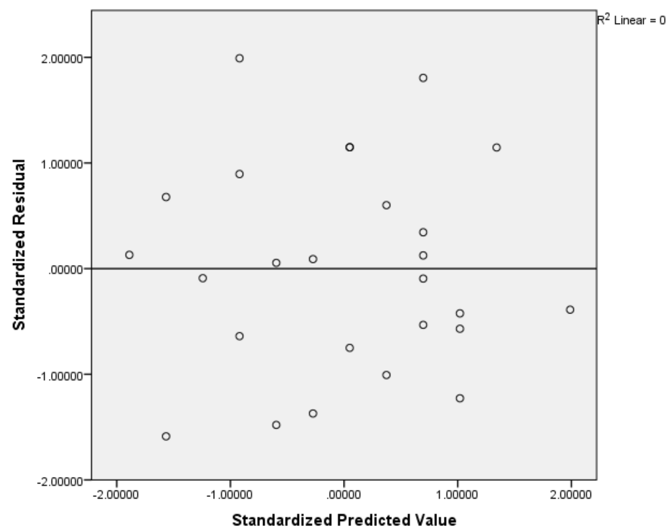
APPENDIX O: Linearity, Homoscedasticity & Absence of Bivariate Outliers



APPENDIX P: Multicollinearity

Correlations			
		meancoop	Change_in_PT
meancoop	Pearson Correlation	1	-.117
	Sig. (2-tailed)		.571
	N	26	26
Change_in_PT	Pearson Correlation	-.117	1
	Sig. (2-tailed)	.571	
	N	26	26

APPENDIX Q: Homoscedasticity of Residuals



APPENDIX R: Hierarchical Linear Regression Model Summary

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Condition[b]	.	Enter
2	Change_in_PT[b]	.	Enter

a. Dependent Variable: meancoop

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.488[a]	.238	.206	2.40625	.238	7.489	1	24	.011
2	.521[b]	.271	.208	2.40397	.033	1.046	1	23	.317

a. Predictors: (Constant), Condition

b. Predictors: (Constant), Condition, Change_in_PT

APPENDIX S: ANOVA Table

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	43.361	1	43.361	7.489	.011[b]
	Residual	138.961	24	5.790		
	Total	182.322	25			
2	Regression	49.403	2	24.702	4.274	.026[c]
	Residual	132.918	23	5.779		
	Total	182.322	25			

a. Dependent Variable: meancoop

b. Predictors: (Constant), Condition

c. Predictors: (Constant), Condition, Change_in_PT

APPENDIX T: Coefficients Table

Coefficients[a]					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		

1	(Constant)	1.052	1.462		.720	.479
	Condition	2.590	.947	.488	2.737	.011
2	(Constant)	.730	1.494		.489	.630
	Condition	2.718	.954	.512	2.850	.009
	Change_in_PT	-.016	.016	-.184	-1.023	.317

a. Dependent Variable: meancoop